It should be clearly understood that neither the recommended increased capacities of outlet canals for the control of Lake Okeechobee nor further increase in outlet capacities within the bounds of reasonable expenditures would be sufficient to hold the water surface of Lake Okeechobee at the same level at all times. In other words, during the rainy season water accumulates in Lake Okeechobee very much faster than it can be taken out by any practical method.

With that definite declaration by the Federal engineers with respect to regulating the stages of Lake Okeechobee the river and harbor act, approved July 3, 1930,

Provided for the flood control of Lake Okeechobee and certain navigable channels leading from the lake to tide water on either side of the peninsula.

The comprehensive character of the project, now being aggressively advanced, is such as to dispel fear and restore confidence in the security of life and property on Lake Okeechobee, all vouchsafed by the integrity of the Federal Government. Both outlets of the lake, namely, the St. Lucie Canal and the Caloosahatchee River, become links in the chain of intracoastal waterways of the United States.

The magnitude of the project is apparent when it is stated that levees, dykes, locks, and other control measures will form a sort of arc of a circle, extending from Fisheating Creek on the southwest shore via Moore Haven, Clewiston, Belle Glade, Pahoka, and Port Mayaca (St. Lucie Canal) on the south, a distance of 63 miles. The standard design of the protection levees provides for a crest elevation of 34 feet above mean low water of the Gulf at Punta Rassa with a crest width of 15 feet, a most formidable and enduring arm of safety.

And as a supplementary agency to regulate the lake stage, the discharge output of the St. Lucie Canal, which is now 5,000 cubic feet per second, is available should any emergency arise.

To combat all danger of floods over the northern shore of the lake, that is the Taylors Creek section, a system of levees similar to that provided for the southern shores will be constructed along the shore from the mouth of the Kissimmee River to and past Taylors Creek, a distance of 24 miles with levees on each side of the creek leading up to Okeechobee City. And there is or will be further safety through the discharge of 2,500 cubic feet per second through the Caloosahatchee Canal from Lake Okeechobee to Fort Thompson, a distance of 23 miles.

The following are coordinate parts of the Lake Okeechobee project:

(*a*) Provide a channel 200 feet wide and 12 feet deep from the Gulf to Punta Rassa.

(*b*) A channel 100 feet wide and 10 feet deep from Punta Rosa to Fort Myers.

(*c*) A channel 80 feet wide and 6 feet deep, Fort Myers to Lake Okeechobee, thence through the lake a channel 6 feet deep and 80 feet wide to the St. Lucie Canal. This canal has a minimum depth of 8 feet and a bottom width of from 150 feet to 165 feet.

The completion of the Lake Okeechobee system in its entirety sustains a relationship to the intracoastal waterways of the United States that is much more than simply a chain or link in that system which, it is conceded, might become an important factor in the communication system of the country during periods of national stress. Then Lake Okeechobee and its associated waterways would become an avenue of ingress and egress for the Gulf of Mexico and the Atlantic Ocean, really an arm of offense and defense of the Navy, making possible a rapid shift from the Gulf to the Atlantic of such forces as might be necessary to meet unexpected attacks, or to make possible a quick offense by the smaller units of the United States Navy.

THE RELATIVE DISTRIBUTION OF EARLY AND LATE SEASONAL RAINFALL IN SOUTHERN CALIFORNIA

By CHARLES C. CONROY

In view of popular and journalistic speculation as to the probability of late rains when early ones have been abundant, and because of the widespread interest in the subject of seasonal precipitation in Southern California, the writer has undertaken to analyze the relative distribution of early and late rainfall in that region. The analysis covers the period from July 1, 1877, to June 30, 1927—50 seasons—and is based upon the records, grouped by decades, of the two regular weather bureau stations—Los Angeles and San Diego. The results are tabulated below. In the tables, column (*a*) shows the total rainfall by decades and for the period; column (*b*) the corresponding early rainfall; column (*c*) its percentage of the decadal and total rainfall; column (*d*) the corresponding late rainfall; column (*e*) its percentage of the decadal and total fall for the period, and column (*f*) the percentage of the total fall represented by the midseasonal rains. The word "early" is used to designate the five months from July 1 to December 1; the word "late" the three months from April 1 to July 1. The expression "mid-seasonal" comprises the months of December, January, February, and March. In the "early" part of the rain year July and August have contributed only an inappreciable amount to the totals, so the early period is really strictly comparable, in length, with the "late" months of April, May, and June.

Los Angeles

	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)
	Inches	*Inches*	*Per cent*	*Inches*	*Per cent*	*Per cent*
1877-87	172.34	19.88	11.5	27.35	15.8	72.7
1887-97	167.69	25.51	15.2	7.08	4.2	80.6
1897-07	132.96	22.47	16.1	15.34	11.5	72.4
1907-17	160.31	17.54	10.9	7.65	4.8	84.3
1917-27	127.79	17.67	13.8	21.26	16.7	69.5
Sums	761.39	103.07		78.68		
Means	152.28	20.61	13.5	15.74	10.6	75.9

San Diego

	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)
1877-87	122.35	13.07	10.7	17.45	17.4	71.9
1887-97	99.15	13.94	14.1	5.26	5.3	80.6
1897-07	88.60	12.98	14.6	12.42	12.4	73.0
1907-17	106.20	16.55	15.6	7.33	7.3	77.1
1917-27	99.65	15.19	15.2	14.34	14.4	70.4
Sums	515.95	71.73		56.80		
Means	103.19	14.35	14.0	11.34	11.4	74.6

The outstanding features of the two tables are (1) the comparative constancy of the early (*c*) and mid-seasonal (*f*) rainfall as expressed in percentages of the whole; and (2) the wide variability and consequent uncertainty of the late rainfall, both in actual amounts (*d*) and in percentages, (*e*). In both Los Angeles and San Diego the departures from the mean are far larger in the late rainfall than in the early, and we may add that the records of the two stations are in close agreement in percentages throughout the 50-year period under discussion.

It is accordingly evident that pressure conditions conducive to rainfall in Southern California are more reliable factors in the autumn than in the spring. The tracks followed by disturbances moving eastward over the coast have in general a more southerly tendency in the autumn, and especially in November. Besides, "lows" which make their way into the Pacific Southwest from Mexico are more frequent in the fall months. Another occasional rainfall factor is the summer "low" over the lower Colorado River valley. This often persists, albeit somewhat weakened, throughout October, and the cooling of the air in the near-by coastal region occasionally operates with this "low" to produce considerable October rains.

On the other hand, the development of secondary "lows" over Nevada occurs more frequently in the spring than in the fall. Nevertheless, these depressions are uncertain causative factors in Southern California's late seasonal rainfall. If the barometric gradient between their centers and the coast is fairly large, it often happens that brisk to strong westerly or northwesterly winds are the only appreciable results of their development. Still, the coastal region sometimes receives a good rainfall from them, and we note that the greater relative frequency of thunderstorms in the Los Angeles area in the spring months is due to the barometric "lag" which remains for a day or two over the Tehachapi Mountains after their centers have moved eastward. In the long run, however, the tables show that rain producing conditions are decidedly more effective in the autumn months.

The direct movement of energetic depressions from the Pacific over or just north of Southern California is infrequent before December or after March. Occasionally, however, this occurs, and the results are seen in the excessive rainfalls of October, 1889, November, 1900, April, 1926, May, 1921, and June, 1884. These exceptional storms are, of course, included in the tabular values given above, but their amounts balance in the fall and spring totals so well that they do not sensibly affect the order of the several absolute and relative values.

Some interest may be taken in a comparison of the 50-year results for Southern California with those of two stations farther north: San Francisco and Sacramento. The following data are for the same period, and the columnar values have the same significance, as the corresponding ones in the southern tables:

San Francisco

	(a)	(b)	(c)	(d)	(e)	(f)
	Inches	*Inches*	*Per cent*	*Inches*	*Per cent*	*Per cent*
1877-87	254.97	41.60	16.3	46.74	18.3	65.4
1887-97	233.16	41.66	17.9	25.72	11.0	71.1
1897-07	193.78	43.29	22.3	20.27	11.5	66.2
1907-17	213.87	25.97	12.1	13.30	6.2	81.7
1917-27	201.37	42.10	20.9	23.42	11.6	67.4
Sums	1,097.15	194.62		129.45		
Means	219.43	38.92	17.9	25.89	11.7	70.4

Sacramento

	(a)	(b)	(c)	(d)	(e)	(f)
1877-87	209.71	32.70	15.7	31.50	15.2	69.1
1887-97	201.26	36.84	18.3	26.65	13.2	68.5
1897-07	186.71	39.82	21.3	23.04	12.3	66.4
1907-17	154.60	17.55	11.4	11.92	7.7	80.9
1917-27	142.85	33.99	23.8	18.65	13.1	63.3
Sums	903.33	160.90		111.76		
Means	180.66	32.18	18.1	24.37	12.3	69.6

It will be remarked that the early rainfall in these tables is remarkably uniform, in actual quantity, in four of the five 10-year periods, and that, in the decade in which it is deficient, an even larger proportional deficiency is found in the season of late rains also. In this particular decade—1907–1917—there is, therefore, an abnormally high relative value for the mid-seasonal rains. But, leaving this decade out of consideration, the others fail to show in the quantity of their late rains the uniformity which is characteristic of their earlier rains. On the whole, however, the irregularities from decade to decade are not so striking as they are in the southern tables, and this because the influence of northern "lows" is much more pronounced, and that of secondary "lows" over southern Nevada much less pronounced, than in the south.

On the other hand, in autumn the centers of nearly all important depressions move over the coast north of the central California stations. The prevailing winds during their passage are from southerly quadrants, and the rainfall in consequence is quite uniform from decade to decade. We find, therefore, that at all four stations the autumnal rainfall régime is similar, whilst in the vernal one considerable differences are introduced between north and south by the occasional development of depressions east or northeast of southern California. The presence or absence of these means a larger proportional element of variability in the southern spring.

While this method of statistical treatment does not afford good indications of the probability of early or late rains in any given year, it is nevertheless a fair indicator of the distribution of these rains in a group of years. In other words, it is a generalized analysis, useful in a broad sense.

SEVERE SAND STORM IN EASTERN WYOMING, JANUARY 18, 1933

By F. L. DISTERDICK

[Weather Bureau office, Cheyenne, Wyo.]

Strong winds are of frequent occurrence over the plains section of Wyoming, but owing to the scarcity there of populous areas their occurrence seldom is noticed. On January 18, 1933, however, a wind and dust storm occurred that was so exceptionally severe that it attracted much attention.

On the morning of this date a cyclone was centered at Lander where the barometer (reduced) read 29.24 inches. The State forecast warned of strong shifting gales. The State highway commission was notified and the usual precaution was taken of stationing sentinels on all highways leaving Cheyenne to warn travelers. The winds of the forenoon ranged from 26 to 30 miles per hour and the storm center apparently moved directly eastward with increasing intensity, and passed out of the State near noon, close to the South Dakota-Nebraska boundary. At Cheyenne the true wind velocity was 65 miles per hour, 2 miles greater than the highest velocity previously recorded. Shortly before noon there was a sudden drop in the barometer soon followed by a decided increase in the wind velocity which for the next five hours was 52, 55, 54, 52, and 46 miles per hour, respectively. For three